

Homework Set #1

(Total Score: 20 points)

1. Draw the lowest order Feynman diagrams for the following processes and discuss briefly what is going on in each case (ignore extra diagrams from time ordering) (1 point each, 4 points total)
 - i. Compton Scattering (scattering of a photon off of a free electron)
 - ii. Photon-photon interaction resulting in e^+e^- production
 - iii. $e^+e^- \rightarrow \mu^+\mu^-$
 - iv. $\nu_\mu e^- \rightarrow \nu_e \mu^-$
2. Derive an expression for the minimum/threshold energy for the reaction $A+B \rightarrow C_1+C_2+\dots+C_n$, in terms of the masses of the particles involved. (4 points)
3. Calculate the threshold energy and beam momentum for the following processes, where the target proton is at rest. (2 points each, 4 points total)
 - i. $\pi^- + p \rightarrow K^- + K^+ + n$
 - ii. $p + p \rightarrow p + p + \pi^+ + \pi^-$

4. In a scattering process $A+B \rightarrow C+D$, the Mandelstam variables s, t, u are the convenient invariant quantities, where $s=(p_A+p_B)^2$, $t=(p_A-p_C)^2$ and $u=(p_A-p_D)^2$, and p_A, p_B, \dots etc. are four-momenta. Also,

$$(p_A + p_B)^2 = (E_A + E_B)^2 - (\vec{p}_A + \vec{p}_B)^2$$

etc. Derive expressions for s, t and u for elastic scattering of identical particles i.e., for $A+A \rightarrow A+A$ in terms of center of mass momentum p of the incident particle, mass of the particle and θ the scattering angle.

(6 points)

5. What is the center of mass energy available in an experiment where a 400 GeV/c proton beam hits a hydrogen target. (2 points).